

ANALYSIS 3: Interior Fit-Out BIM Implementation

Problem Identification

When building a speculative office building, owner's are burdened with finding a tenant to lease the space. This can be a stressful situation especially when the speculative office market is on a decline. One reason that leasing a space can be difficult is most potential tenants cannot visualize the space and prefer to wait to sign a contract until the shell building is complete. Bridgeside II is designed to meet the demand for laboratory space and will accommodate 80 percent laboratory space and 20 percent office space. It is also designed with an open floor plan to accommodate a variety of layouts. Once a tenant is identified, it is their responsibility to determine their space layout. Building Information Modeling can be beneficial during the design phase due to its ability to organize information. It also provides a stronger visualization of the building. BIM was not utilized during the core and shell phase or the interior design phase of the Bridgeside II project.

Proposal

For this analysis I will propose to utilize BIM for the interior design phase of Bridgeside II. Owners are sometimes hesitant to utilize BIM because they are unfamiliar with it and do not know how to apply it to their project. For this analysis I will determine how much detail should be incorporated into the model, who will be responsible for the details, and what some of the specifications should be for how BIM will be applied. This will be accomplished through research, case studies, and interviews with industry members who are familiar with BIM.

Goal

The goal of this analysis is to determine a standard of detail to be used for interior fit-out models and to determine how BIM should be applied to the Bridgeside II project. This analysis will define responsibilities and what the owner should expect by utilizing BIM. The goal when determining the model requirements is to use enough detail so the designers and potential tenants can design a space and allow the tenants to see what they would be paying for. This would be beneficial to the project because multiple layouts can be designed more efficiently and tenants will hopefully agree on a lease before the shell building is complete, which would speed up the fit-out process.

Methodology

- 1) Determine a set of questions to base the analysis on.
- 2) Answer the questions through research and interviews with industry members.
- 3) Determine the benefits of using BIM on the Bridgeside II project and what the specifications should be.
- 4) Analyze the model benefits for potential clients.
- 5) Develop a set of criteria for the amount of detail incorporated into the interior models.

Analysis Questions

- 1) In what ways is BIM beneficial for interior fit-outs?
- 2) How will potential tenants utilize a BIM model when designing their space?
- 3) What are the cost and schedule implications of implementing BIM?
- 4) What deters owners from implementing BIM on their projects?
- 5) What are the model requirements for interior design?

BIM and Interior Design

It has already been proven that BIM is a valuable resource for construction projects. It provides 3D and 4D visualizations, detects clashes, manages changes, and acts as a database for all the project information. For obvious reasons, the BIM benefits that are typically focused on pertain to the structural, building enclosure, and MEP phases. These phases drive the schedule of a building project. BIM also provides a number of benefits for the interior fit-out phases especially for core and shell projects where a tenant has not been arranged and the interior layout is not designed. Some of the benefits and uses are listed below.

- The speed and ease of creating an interior model.
- The ability to visualize the design, which is important to potential tenants.
- The ability to create multiple interior designs on one building model, which will accommodate multiple tenants or multiple ideas.
- Organizing material information, cost data, schedules, and material quantities.

One of the difficulties with core and shell projects is the change in teams for the fit-out phase. Core and shell projects typically have a different design team for the interior phases and this can be difficult because they are unfamiliar with the project. The new team will be given the plans but they essentially have to redesign the project similar to a building renovation. If BIM is used on a core and shell project then the interior design team can start with an accurate model, which will save time.

One of the benefits of BIM that will be useful for the Bridgeside II project is the service it will provide for the potential tenants. Interior models allow tenants to plan their space before the building is complete. Tenants can design open floor plans, closed office space, material selections, and furniture locations efficiently. The model can also be rendered to give the tenant a clear visualization of their material and lighting selections. The visualization aspect of BIM is important because it allows designers to try different materials and evaluate their designs. It is easy to picture a brick building verses a metal panel façade but interior spaces are more difficult. Figure 3.1 is an example of an interior rendering developed by Autodesk. Non-graphical information, such as material properties, lead times, and cost data, is also important to owners and tenants. BIM models easily organize this information for each interior design and can perform material takeoffs. This is important because tenants typically have a budget and the material takeoffs can be used to perform quick estimates for their designs.



Figure 3.1 – Interior Rendering Example

Bridgeside II is designed to accommodate multiple layouts per floor or a tenant can lease entire floors. With all the tenant and floor plan combinations there are many potential designs. Modeling software allows you to create multiple floor plan designs within one model. This is beneficial because the different designs, costs, and schedules can be easily compared. Currently the only potential tenant for Bridgeside II is the University of Pittsburgh. They would be leasing the building to fill their need for additional laboratory space. One of the most difficult tasks for inexperienced building tenants is to visualize a building or floor plan when looking at two dimensional drawings. This often makes them hesitant to lease a space before they can see it. I believe that implementing BIM for interior fit-outs will help potential tenants visualize their space and help alleviate some of their hesitations. The University of Pittsburgh would be able to use BIM to layout their laboratory and office spaces in relation to the utilities, wet stacks, and fume hoods. They could also utilize the model to organize all the information for their equipment and appliances that will be in the labs.

Cost and Schedule

The use of BIM on construction projects is becoming an expected service. Architects and engineers previously charged extra and required extra time to develop the model. However, as owners started to expect BIM models the initial charges have decreased or were removed and the modeling time became part of the schedule rather than a delay. Many design professionals develop models regardless of whether it is required; therefore, their fees and schedules are not affected. Design professionals who lack the technology and training to accommodate BIM specifications may find themselves at a competitive disadvantage. The transition from core and shell teams to interior fit-out teams is improved with the use of BIM. Assuming that BIM is utilized for the entire project, the interior fit-out schedule would be reduced because the design team would have an accurate informational model to work with. The alternative would require the design team to work off of two dimensional drawings and redesign parts of the building. A BIM model provides more project information and is in a format that can be developed further, compared to a set of as-built documents.

BIM Specifications

One of the largest obstacles when choosing to utilize BIM on a construction project is getting all the project teams to agree on their responsibilities to each other and to the model. The ambiguity in implementing BIM causes many owners to shy away. The key to success is defining the responsibilities from the beginning of the project to prevent future conflicts. This can be difficult because BIM often requires different relationships between project participants than those they typically employ. The model requires timely and updated information, increasing the amount of communication required. Other specifications regarding the model that need to be stated include; who owns the model rights, access rights, and the model intentions. If the model is only being used during the design phase and not for construction, it should be specified because it will affect the level of detail in the model.

There are two documents that were released to assist project teams in adopting BIM. The first is a Model Progression Specification developed by Webcor Builders, VICO, and AIA California Council's Integrated Project Delivery Task Force. The second document is AIA Document E202 titled Building Information Modeling Protocol Exhibit. These two documents assist project teams to determine the purpose of the model, the level of detail, and the responsible parties.

The Bridgeside II project team had considered using BIM for pieces of the interior design but opted against it due to uncertainties about responsibilities and schedule implications. AIA E202 is an important tool for implementing BIM because it allows owners to specify some of the BIM requirements in a contractual form for the owner/architect and owner/contractor agreements. It is especially beneficial for inexperienced project teams because it identifies the important aspects of BIM such as responsibilities, level of detail, and file requirements. AIA E202 was released in 2008, after the start of the Bridgeside II project. If they had this document they may have been more willing to utilize BIM because it provides a more user friendly method to determine the scope of the model. The AIA document defines important BIM decisions and provides the owner with a space to specify their preferences. The items set up for the owner to specify within the contract language are listed below.

- Model standards
- File formats for model uses
- Responsible parties for model management
- Model archive requirements
- Model uses per level of detail
- Model Element Authors

After the owner determines who will be responsible for managing the model, the AIA document specifies the initial responsibilities required for the model and what the ongoing responsibilities will be throughout the project. This is especially important because the responsibilities of the model manager are written in a contractual language preventing future conflicts regarding responsibility for updating and managing the model. The initial and ongoing model responsibilities are shown in figures 3.2 and 3.3.

§ 2.4.2 Initial Responsibilities. The party responsible for managing the Model shall facilitate the establishment of protocols for the following:

- .1 Model origin, coordinate system, and units
- .2 File storage location(s)
- .3 Processes for transferring and accessing Model files
- .4 Clash detection
- .5 Access rights
- .6 Other protocols:
(Insert additional protocols below.)

Figure 3.2 – Initial Model Responsibilities

§ 2.4.3 Ongoing Responsibilities. The party responsible for managing the Model shall have the following ongoing responsibilities:

- .1 Collect incoming Models:
 - .1 Coordinate submission and exchange of Models
 - .2 Log incoming Models
 - .3 Validate that files are complete and usable and in compliance with applicable protocols
 - .4 Maintain record copy of each file received
- .2 Aggregate Model files and make available for viewing
- .3 Perform clash detection in accordance with established protocols and issue periodic clash detection reports
- .4 Maintain Model archives and backups
- .5 Manage access rights
- .6 Follow protocols established in Section 2.4.2

Figure 3.3 – Ongoing Model Responsibilities

Another requirement that owners experienced in BIM often specify is for the general contractor or construction manager to submit an implementation plan. The implementation plan will describe how the model will be utilized from the conceptual design phase through the as-builts. Areas where the model will be used and should be described include; design, construction, coordination, scheduling, cost estimating, and documentation. This is beneficial because the owner and contractor will have to come to an agreement on how the model will be utilized.

Model Requirements

A BIM has many potential uses and each use requires a certain level of detail in the model. Through each phase of the project the model becomes more precise and it can be confusing to determine what it can be used for. In addition, it is possible that the author of the model did not consider all of the potential uses. If the model is misinterpreted then this will lead to inaccurate outputs. The Model Progression Specification was developed to assign specific uses to each level of detail as the model progresses. It is also beneficial to owners because they can specify what they want to use the model for and what level of detail will be required. The MPS was incorporated into the AIA BIM Protocol document to allow the levels of detail to be specified in the contract. This prevents confusion over when the model can be used and who is responsible for each level of detail.

The Model Progression Specification defines 5 levels of detail labeled 100 through 500. Each of the 5 levels has a minimum level of detail that must be incorporated into the model and specifies how the model can be used at that level. The authorized uses per level of detail include; cost estimating, 4D scheduling, program compliance, sustainable materials, and environmental. Each level in the MPS is

authorized to provide more detail for each of the uses than the previous level. The AIA E202 incorporates each of the detail levels and authorized uses and it allows the owner to write in additional uses at each level. Table 3.1 shows each of the levels of detail and how detailed each of the authorized uses can be. The second part of the Model Progression Specification is used to determine responsibility. Most of the building components are listed, such as the structure and the shell, and under each level of detail the responsible party is listed. This clearly defines who is responsible for the details at each phase of the model. Table 3.2 shows the model progression responsibilities for the interior components. The responsible parties can be adjusted to meet the needs of the project and team members. The MPS is progressing BIM because it clearly defines how much detail is necessary for certain model purposes and who is responsible for the detail. This prevents conflicts and misinterpretations of the model.

Table 3.1 – MPS Levels of Detail

Model Content	100	200	300	400	500
Design & Coordination~(function / form / behavior)	Non-geometric data or line work, areas, volumes zones, etc.	Generic elements shown in three dimensions - maximum size - purpose	Specific elements Confirmed 3D Object Geometry - dimensions - capacities - connections	Shop drawing/ fabrication - purchase - manufacture - install - specified	As-built - actual
Authorized uses	100	200	300	400	500
4D Scheduling	total project construction duration phasing of major elements	Time-scaled, ordered appearance of major activities	Time-scaled, ordered appearance of detailed assemblies	fabrication and assembly detail including construction means and methods (cranes, man-lifts, shoring, etc.)	
Cost Estimating	Conceptual cost allowance Example \$/sf of floor area, \$/hospital bed, \$/parking stall, etc. assumptions on future content	Estimated cost based on measurement of generic element. E.g., generic interior wall.	Estimated cost based on measurement of specific assembly. E.g., specific wall type.	Committed purchase price of specific assembly at Buyout.	Record costs
Program Compliance	Gross departmental areas	Specific room requirements	FF&E, casework, utility connections		
Sustainable Materials	LEED strategies	Approximate quantities of materials by LEED categories	Precise quantities of materials with percentages of recycled/locally purchased materials	Specific manufacturer selections	purchase documentation
Environmental: Lighting, Energy use, air movement Analysis/Simulation	Strategy and performance criteria based on volumes and areas	Conceptual design based on geometry and assumed system types	Approximate simulation based on specific building assemblies and engineered systems	Precise simulation based on specific manufacturer and detailed system components	Commissioning and recording of measured performance

Table 3.2 – Interior Model Responsibilities

Element (ASTM Uniformat II Classification)				Level of Detail (LOD) and Model Component Author (MCA)							
				Conceptual-ization		Criteria Design		Detailed Design		Implemen-tation Docs	
				LOD	MCA	LOD	MCA	LOD	MCA	LOD	MCA
C INTERIORS	C10 Interior Construction	C1010 Partitions	100	PD	200	PD	300	PD	400	TC	
		C1020 Interior Doors	100	PD	200	PD	300	PD	400	TC	
		C1030 Fittings	100	PD	100	PD	300	PD	400	TC	
	C20 Stairs	C2010 Stair Construction	100	PD	200	PD	300	TC	400	TC	
		C2020 Stair Finishes	100	PD	100	PD	100	TC	100	TC	
	C30 Interior Finishes	C3010 Wall Finishes	100	PD	100	PD	100	PD	100	TC	
		C3020 Floor Finishes	100	PD	100	PD	100	PD	100	TC	
		C3030 Ceiling Finishes	100	PD	100	PD	100	PD	100	TC	

Model Component Authors:

- PD – Prime Designer
- DC – Design Consultants
- PC – Prime Constructor
- TC – Trade Contractors
- S – Suppliers

BIM Implementation

The Bridgeside II project could benefit from any of the various BIM uses, however, based on the project needs I believe the most beneficial aspect would be visualization. Throughout the duration of the project, the Ferchill Group has been working to obtain tenants for the building. As soon as a tenant is arranged then the preconstruction work can begin for the interior design and this will expedite the schedule if it can be overlapped with the shell construction. The Bridgeside II floor plans are flexible and can be designed to the tenants needs. Unless the potential tenant is experienced in interior design, they probably won't be able to visualize the space from a set of two dimensional drawings. This may make them hesitant toward leasing an unfinished space. Being able to visualize the space with the use of a model is very beneficial because it allows the design team and tenants to work together and agree on a design. It also allows the tenants to select materials and compare various layouts with one model. If some or all of the tenants were arranged during the core and shell phases then they would be able to have their design finalized and get their long lead time materials and equipment ordered before the interior fit-out phases begin. By speeding up the schedule the tenants will be able to move in sooner and the Ferchill Group will begin receiving rent payments.

In order to provide the tenants with a valuable design tool the interior model would need to have at least a level of detail of 300. A model with a level of detail of 300 requires all the assemblies to be accurate including; quantity, size, shape, location, and orientation. This level of detail also accommodates non-geometrical information attached to the model. In addition to visualization, the cost and schedule data is very important to tenants. A 300 level of detail will have enough information to create cost estimates based on specific data and conceptual estimate techniques. With this model tenants will be able to create accurate budgets and compare the cost of several designs and material selections. For the schedule, the tenants will be provided with an accurate completion date and the

model will have enough detail and information to support a four dimensional model. A 4D model will be more beneficial for the designers and contractors during the construction phases but it will also provide the tenants with a graphical method of keeping track of progress. If BIM is utilized for the entire project then the interior designers can take the existing model and add the interior details. Otherwise, the interior designers would also have to model the building shell and it would take more work to develop a model with a level of detail of 300. The 300 level is detailed enough to create shop drawings and as more detail is added it will result in an as-built model that can be saved by the building owners for future construction and reference.

Conclusions and Recommendations

The use of Building Information Modeling is growing in the construction industry and with the creation of the Model Progression Specification and the AIA BIM Protocol Exhibit it is easier for owners to specify in contract language how they want to apply a model. They also help owners, designers, and contractors determine who is responsible for the various details in the model. Out of all the benefits that BIM can provide for a building project I believe the visualization aspect is the most beneficial for Bridgeside II. I feel that the ability to see a three dimensional space and easily alter designs will attract potential tenants and help them reach an agreement with the owner at an earlier date in the project. I recommend that at least a detail level of 300 be developed in the model to provide the tenants with an accurate representation of their space and reliable cost and schedule data. Using BIM from the start of the project could result in a schedule reduction for the interior fit-out phases. This is because the interior designers will have an accurate model to work with and they won't need to redesign any part of the building. Also the use of BIM will hopefully attract some tenants earlier in the project resulting in earlier design considerations. In conclusion I feel that utilizing BIM for at least the interior fit-out phases of Bridgeside II would be a valuable addition to the project. This is based on the benefits it provides for the project teams and potential tenants and the use of the BIM specifications to provide contract requirements.